FUTURE VENUS PROBE MISSIONS

Larry W. Esposito

25 August 2004

Most Visited Planet

- 23 space missions: 5 USA; 18 USSR
- Mariner 2,5,10; Pioneer Venus; Magellan
- Venera 1-16; VEGA 1,2
- Descent and landing at 17 locations

VENERA

- Soft landings: Venera 7 - VEGA 2
- Black-and-white and color panoramas of Venus surface
- Cloud properties and the elemental composition of surface rocks
- Radio mapping of the Northern hemisphere, with resolution 1-2 km.

PIONEER VENUS

- Orbiter, bus; large and 3 small probes
- Spectral, radiometric, and polarimetric studies of the upper cloud; UV images
- Atmospheric structure and chemical composition; net flux, winds; spatial variability among the descent paths

MAGELLAN

- Radar mapping of entire surface at better than 300m resolution
- Global topography, crater distribution, tectonics, volcanism
- Evidence for global cataclysm; indirect information on bulk composition, crust-mantle interactions and surface evolution
- High dielectric mountain tops

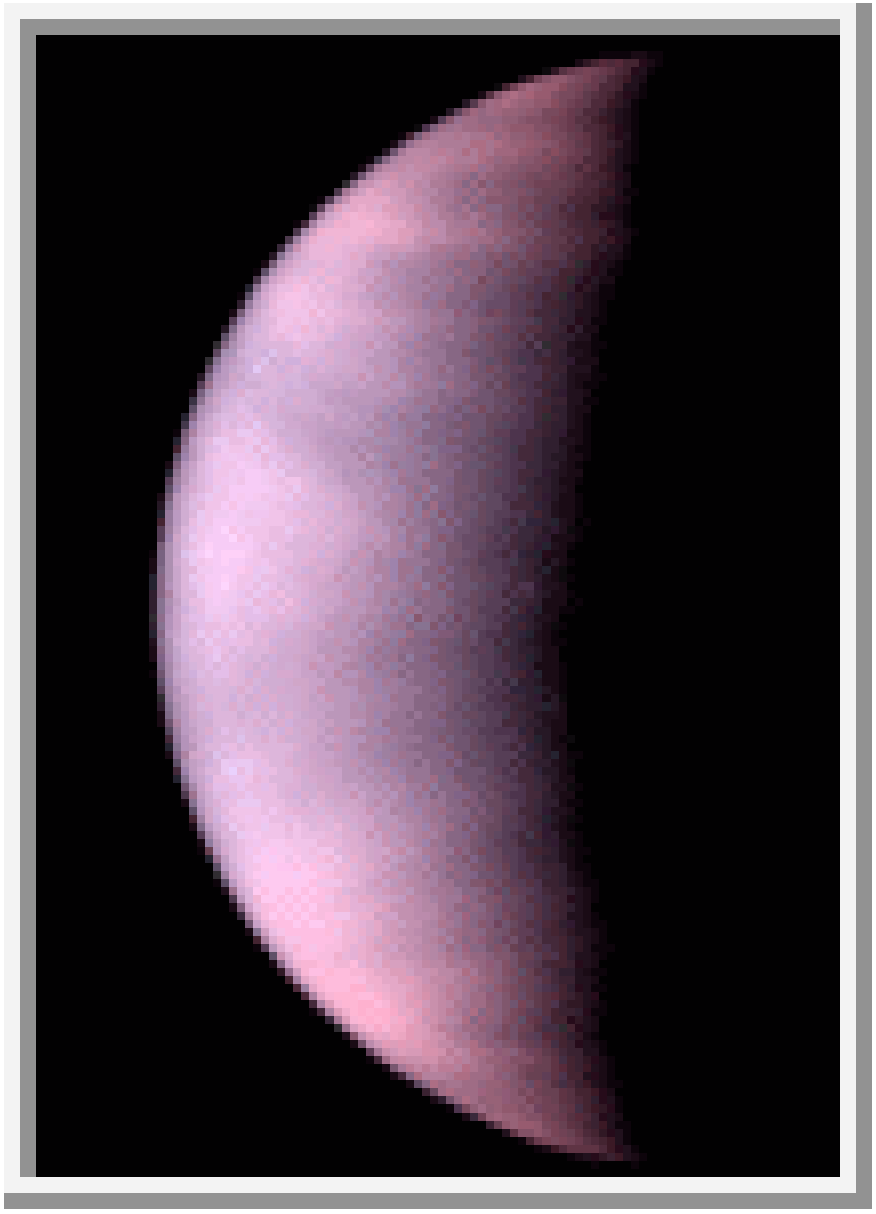
GALILEO, CASSINI & GROUND-BASED

- Observation in NIR windows show thermal emission from surface, atmosphere below clouds, lower and middle clouds
- Some higher resolution studies from the flybys extend spacecraft results

HST

- Hubble observations show continuing decline of sulfur dioxide at cloud tops 1978-1995
- This visible change highlights sensitivity of Venus climate to volcanic activity and surface-atmosphere feedbacks

VENUS FROM HUBBLE 1995



DISCOVERY PROPOSALS

- Emphasize chemistry or dynamics or surface
- Some have gone to ‘Step 2’, but none selected for flight
- Discovery is too focused to answer the coupled chemistry/radiation/dynamics and the surface-atmosphere interactions?

PLANNED FUTURE MISSIONS

- VEX: ESA's Venus Express
  - Reflight of Mars Express bus and experiments in 2005
- VCO: Japan's Venus Climate Orbiter
  - Orbiter emphasizes dynamics and lightning
  - Planned 2009 launch

DECADAL SURVEY MEASUREMENT GOALS

- Composition: trace gases and isotopes
- Noble gas isotopes
- Cloud level winds
- Near IR descent images of surface
- Surface elemental abundance and mineralogy
- Surface texture and weathering

CURRENT STATUS

- Multiple past missions to Venus leave key questions unanswered
- Better sensitivity is essential for atmospheric and surface measurements
- Discovery can’t address couplings
- Entry probes are essential and complement planned international missions

PROBE SURFACE OBJECTIVES

- Elemental and mineral composition and its variation for bulk and interior properties
- Visit tessera and high reflectivity areas for history and weathering
- Surface ages define timescale of volcanic emplacement
- Surface images for context, texture for current processes

PROBE ATMOSPHERIC OBJECTIVES

- Noble gas abundances and isotopic ratios for formation, history and escape
- Vertical profiles of reactive gases for chemistry, clouds and radiation
- Wind profiles for dynamics, stability
- Thermal structure for energy balance
- Surface winds for aeolian processes

SURFACE-ATMOSPHERE INTERACTIONS

- Simultaneous atmospheric chemistry and surface mineralogy
- Horizontal variations in atmospheric composition
- Current rates for volcanic re-surfacing, and atmospheric injections

LONG LIVED LANDERS

- Measure heat flow for interior processes
- Magnetic field for core properties, remnant magnetism
- Seismology for current activity and interior structure
- Laboratory investigations of surface samples

IMPLICATIONS FOR OTHER PLANETARY SYSTEMS

- History and detectability of terrestrial planets
- Identify Venus-like planets (are these really ‘false positives’)
- Understand why Earth and Venus diverged
- Is Venus Earth’s fate?

SUMMARY

- Probes are essential to understanding Venus
- Direct implications for Earth's formation and history, origin of life, extra solar planets
- Range of desired capability includes
  - Multiprobes
  - Descenders
  - Landers
  - Balloons
  - Long-lived landers